WHAT IS CLAIMED IS:

1. A superconducting magnet apparatus comprising:

a vacuum vessel;

a superconducting coil accommodated in the vacuum vessel; and

one or more refrigerators attached to the vacuum vessel to cool the superconducting coil,

wherein the refrigerator comprises:

a motor drive;

a displacer attached to the motor drive and driven by the motor drive; and

a cooling cylinder accommodating the displacer so as to allow the displacer to reciprocate,

the vacuum vessel being formed of a double-cylindrical structure having a hollow space in its center,

a sleeve being provided in the vacuum vessel to accommodate the cooling cylinder by isolating it from a vacuum area in the vacuum vessel, and the sleeve having an opening near the wall of the vacuum vessel,

the cooling cylinder being partly in surface contact with the sleeve,

an opening portion of the cooling cylinder through which the displacer is inserted having a first flange to which the motor drive is installed with the displacer inserted therein and also having a cylindrical portion inserted into the sleeve to seal the space in the sleeve, and

a sealing ring being provided between the cylindrical portion and an inner wall of the sleeve that opposes the cylindrical portion,

the motor drive and the displacer being capable of removing from the vacuum vessel, leaving the first flange and the cooling cylinder.

2. The superconducting magnet apparatus according to Claim 1, wherein

the vacuum vessel is provided with at least two pairs of vertically disposed superconducting coils opposing each other with the hollow space therebetween,

an angle formed by central axes of adjoining superconducting coils of adjoining pairs is set to 90 degrees or less, and

a resultant generated magnetic flux forms a horizontal magnetic field passing through a vertical central axis in the hollow space.

3. The superconducting magnet apparatus according to Claim 1, wherein

the vacuum vessel is provided with at least two pairs of vertically disposed superconducting coils opposing each other with the hollow space therebetween,

an angle formed by central axes of adjoining superconducting coils of adjoining pairs is set to 90 degrees, and

a resultant generated magnetic flux forms a cusp magnetic field that does not pass through a vertical central axis in the hollow space.

4. The superconducting magnet apparatus according to Claim 1, wherein the vacuum vessel is provided with horizontally disposed annular superconducting coils that surround the hollow space and are disposed at an upper side and a lower side to generate, using the upper and lower superconducting coils, a vertical magnetic field formed of a parallel magnetic field directed from top to bottom or a vertical magnetic field formed of a parallel magnetic field directed from bottom to top.

5. The superconducting magnet apparatus according to Claim 1, wherein the vacuum vessel is provided with horizontally disposed annular superconducting coils that surround the hollow space and are disposed at an upper side and a lower side, and

a magnetic flux generated by the upper and lower superconducting coils is reversed to produce a cusp magnetic field that does not pass through the vertical central axis in the hollow space.

6. The superconducting magnet apparatus according to Claim 1, wherein

a second flange opposing the first flange is integrally provided with the vacuum vessel in the vicinity of the opening of the sleeve such that the second flange slightly juts out of the vacuum vessel,

the first flange and the second flange are fastened together with a plurality of first bolts, and

at least one guide pin for restricting the tilt of the cooling cylinder caused by the displacer when the cylindrical portion is inserted in the sleeve is provided between the first flange and the second flange.

7. The superconducting magnet apparatus according to Claim 6, wherein

the plurality of first bolts is inserted from the second flange to the first flange such that it passes through the second flange in a loosely fitted manner, and

a spring washer is placed between heads of the first bolts and the second flange against which the heads face.

8. A superconducting magnet apparatus for a single crystal pulling device, comprising a single crystal pulling device in the hollow space of the vacuum vessel in the superconducting magnet apparatus according to Claim 1.

9. A maintenance method of a refrigerator in the superconducting magnet apparatus according to Claim 6, surface contact between a part of the cooling cylinder and the sleeve being effected on a plane perpendicular to a direction in which the cooling cylinder extends, and replacing the displacer comprising the steps of:

removing a predetermined number of the plurality of first bolts;

loosening the remaining first bolts;

screwing second bolts from the first flange side into the holes, from which the first bolts have been removed, to detach the first flange from the second flange so as to draw out the cylindrical portion by a few millimeters, thereby clearing the surface contact while maintaining the sealing between the sleeve and the cooling cylinder;

removing the second bolts and the motor drive from the first flange to draw out the displacer from the cooling cylinder;

increasing the temperature in the cooling cylinder;

inserting a new assembly of the motor drive and the displacer into the cooling cylinder through the first flange;

applying a pressing force by a booster to a head of the motor drive to push the cylindrical portion back to its original position so as to bring a portion of the cooling cylinder and the sleeve back into surface contact; and

tightening the first bolts.

10. The maintenance method of a refrigerator in the superconducting magnet apparatus according to Claim 9, wherein

the booster comprises a base plate to be disposed adjacently to the head of the motor drive, an extending force generating mechanism to be disposed between the base plate and the head of the motor drive, and at least two fastening plates having upper and lower hooks to be hooked on the base plate and the second flange, respectively, and

a pressing force is applied to the head of the motor drive by generating a force to pull the base plate and the head of the motor drive apart from each other by the extending force generating mechanism, while restraining the base plate from moving upwards by the fastening plates.